KROHN-HITE

MODEL 1200A
OPERATING and MAINTENANCE MANUAL

0.2Hz to 3MHz

FUNCTION GENERATOR

SERVICE AND WARRANTY

KROHN-HITE Instruments are designed and manufactured in accordance with sound engineering practices and should give long trouble-free service under normal operating conditions. If your Instrument fails to provide satisfactory service and you are unable to locate the source of trouble, contact our Representative if there is one in your area or write to our Service Department giving all the information available concerning the failure.

Do not return the instrument without our written authorization for, in most cases, we will be able to supply you with the information necessary to repair the instrument and thus avoid the transportation problems and costs. When it becomes necessary to return the instrument to our Factory, kindly pack it carefully and ship it to us prepaid.

All KROHN-HITE products are warranted against defective materials and workmanship. This warranty applies for a period of one year from the date of delivery to the original purchaser. Any instrument that is found within the one year period not to meet these standards, will be repaired or replaced. This warranty does not apply to electron tubes, fuses, or batteries. No other warranty is expressed or implied.

KROHN-HITE CORPORATION reserves the right to make design changes at any time without incurring any obligation to incorporate these changes in instruments previously purchased.

Modifications to this instrument must not be made without the written consent of an authorized employee of KROHN-HITE CORPORATION.

.2Hz TO 3MHz

FUNCTION GENERATOR

MODEL 1200A SERIAL NO._____

OPERATING AND MAINTENANCE MANUAL

KROHN-HITE CORPORATION

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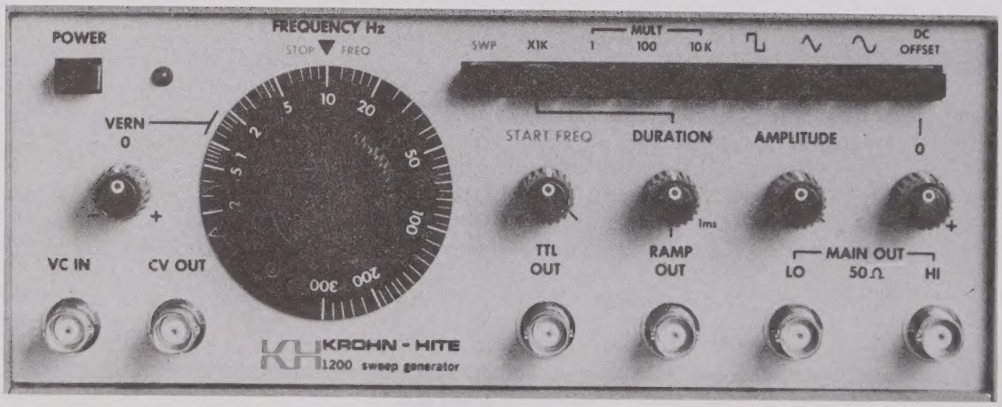


Figure 1. Model 1200A Function Generator

SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The KROHN-HITE Model 1200A, illustrated in Figure 1, combines a function generator and ramp generator in one instrument. An exclusive feature of the 1200A is WAVEGUARD™, a unique output protection circuit that protect's the generator's MAIN (HI) OUTPUT from damage, if a voltage is accidently placed across the output terminals. The WAVEGUARD circuit recovers automatically when the external voltage is removed.

The main generator provides sine, triangle and square waveforms from 0.2Hz to 3MHz. Frequency is controlled by the tuning dial, calibrated in Hertz from .2 to 30 (1500:1) plus a 3 band, decade multiplier. A fine-tune vernier provides ±2.5% adjustment of the dial setting. Frequency may be also controlled externally by an AC or DC voltage applied to the external voltage control (VC) input.

The auxiliary ramp generator, when engaged by the SWP mode button, continuously sweeps the main generator frequency over a 1500:1 range, either up or down, on each multiplier band. Sweep rate is adjustable from 1000 seconds to 1 millisecond.

The main (HI) output amplitude is continuously adjustable from 5mV p-p to 20 volts p-p, open-circuit. Output impedance is a constant 50 ohms. A simultaneous LO (-20dB) output is also provided.

Additional features include: ±10V variable DC offset, auxiliary TTL output and a calibrated CV (control voltage) output, proportional to the main generator frequency.

A Rack-Mounting Kit, Part No. RK-39, is also available.

The generator is carefully inspected, aged and adjusted before shipment, and should be ready for operation when it is unpacked. If it appears to have been damaged in shipment, file a claim with the freight carrier, and notify KROHN-HITE or its nearest sales office immediately.

1.2 SPECIFICATIONS

Waveforms

Sine, square, triangle, TTL, ramp.

Frequency Range:

0.2Hz to 3MHz.

Frequency Control:

Single turn dial calibrated logarithmically from 0.2 to 300 in Hertz, and a 3 position multiplier providing a 1500:1 coverage in each multiplier position. Separate fine-tune vernier provides 5% adjustment.

BAND	MULTIPLIER	FREQUENCY RANGE (Hz)
1	1	0.2 - 300
2	100	20 - 30k
3	10K	2k - 3M

Frequency Accuracy:

±5% at three dial calibration settings of 10, 100 and 300; ±20% maximum at other settings.

Main Output:

WAVEFORMS: Sine, square, triangle.

OUTPUT: HI LEVEL (0db): 20 volts p-p open-circuit, 10 volts p-p across 50 ohms.
LO LEVEL (-20db): 2 volts p-p open-circuit, 1 volt p-p across 50 ohms.

ISOLATION: Can be floated up to ±200 volts peak between outputs and instrument case.

AMPLITUDE STABILITY (MAXIMUM AMPLITUDE):

10 minutes	0.02%
24 hours	0.1%

AMPLITUDE CONTROL: Infinite resolution vernier. Minimum output less than 5 millivolts.

FREQUENCY RESPONSE: Sine wave, less than 0.1db from 0.2Hz to 300kHz; 1.0db to 3 MHz.

SINE WAVE DISTORTION: Less than 0.5% from 2Hz to 300kHz; 3% to 3MHz.

SQUARE WAVE: Rise and fall time, less than 40ns; total abberations less than 5% with 50 ohm termination.

DC COMPONENTS: All waveforms are normally symmetrical about ground with nominal zero DC volts. At maximum output, drift is less than 5 millivolts per degree C.

TRIANGLE LINEARITY: Greater than 99% from 0.2Hz to 300kHz; 95% to 3MHz.

TIME SYMMETRY: Sine, square, triangle 99% from 0.2Hz to 300kHz.

Operational Modes:

Continuous or linear sweep.

Sweep Characteristics:

SWEEP RANGE: Maximum 1500:1 up or down; upper and lower limits set by tuning dial and START FREQUENCY control.

SWEEP DURATION: 1000s - 1ms in two ranges; 1000s - 1s, 1s - 1ms.

RAMP OUTPUT: +5V peak sawtooth, frequency adjustable with DURATION control, .001Hz - 1kHz. Ramp retrace, less than 75us. Output impedance, constant 600 ohms.

External Frequency Control (VC):

RANGE: 1500:1.

VOLTAGE CONTROL RANGE: Zero to ±3 volts. (A maximum of ±25 volts may be applied to the VC input without damage to the circuitry).

INPUT IMPEDANCE: 10k ohms.

Variable DC Offset:

±10 volts open-circuit, ±5 volts across 50 ohms. Push-button ON-OFF Control with separate vernier. (Reduced by -20db on LO output).

TTL Output:

TTL pulse at generator frequency, drives up to 10 TTL loads; rise and fall times less than 15ns.

Control Voltage (CV) Output:

+2mV to +3 volts, proportional to generator frequency. Accuracy, better than 5%. Output impedance, 600 ohms.

Operating Ambient Temperature Range:

-10°C to 45°C.

Controls:

Front panel contains FREQUENCY dial, frequency VERNier, START FREQuency, DURATION, AMPLITUDE, DC OFFSET and push-button controls for frequency range MULTiplier, MAIN OUTput waveform selector, SWP on, sweep range multiplier, and POWER switch. Rear panel contains LINE switches, SYMmetry ADJust, DC LEVEL ADJustment and GROUND switch.

Terminals:

Front panel only, BNC connectors for HI and LO outputs, TTL output, CV output, RAMP output, and VC input.

Power Requirements:

Switch selectable, 90-110, 108-132, 180-220, or 216-264 volts, single phase, 50-400Hz, 13 watts.

Dimensions and Weights:

Cabinet Size/Weight	H	W	D	Net	Gross
U.S.	3-1/2"	9"	8-1/2"	5 lb.	7 lb.
Metric	9 cm	23 cm	21.7 cm	2.3 kg	3.2 kg

Optional Rack Mounting Kit (see Figure 2):

Part No. RK-39; permits installation of the Model 1200A into a standard, 19" rack spacing.

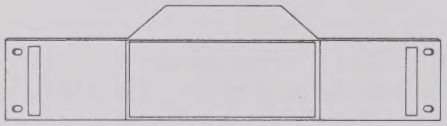


Figure 2. Optional Rack Mounting Kit

Specifications apply at 25°C, ±5°C at maximum output voltage, and dial set between 2 and 300, unless otherwise noted.

Specifications subject to change without notice.

SECTION 2

OPERATION

2.1 POWER REQUIREMENTS

The Model 1200A is designed to operate from a single phase, 50-400Hz AC power source of 90-110, 108-132, 180-220 or 216-264 volts. Complementary LINE switches on the rear panel allow the 1200A to be powered from one of the above 4 voltage ranges. The AC power recptacle located on the rear panel, is a standard 3-pin connector. A detachable 3 wire line cord is provided with the instrument.

The fuse receptacle contains either a 1/8 ampere slow blow fuse (90-132 volt operation) or a 1/16 ampere slow blow fuse (180-264 volt operation).

To turn the instrument on; a) set the LINE switches for the correct AC line voltage range; b) check for or insert the properly rated fuse into the fuse receptacle and secure; c) make sure the front panel POWER switch is off (out) before you connect the line cord to the AC power source; d) depress the POWER switch and allow the generator to warm up for several minutes.

> **CAUTION !**
>
> The cover of this instrument should not be removed when the instrument is connected to an AC power source, because of the potentially dangerous voltages that exist within the unit.

2.2 OPERATING CONTROLS AND CONNECTORS (see Figure 3)

2.2.1 Front Panel

POWER: Push-button ON-OFF switch and power ON indicator light.

FREQUENCY Hz/STOP FREQ: Single turn dial, calibrated in Hertz from .2 to 300, with a separate, fine-tune VERNier, plus a 3 position, push-button MULTiplier switch, X1, X100 and X10K. Effective dial tuning range 1500:1. The output frequency is the dial setting, in Hz, times the MULTiplier setting, with the VERNier in its (0) position. In the sweep mode of operation the DIAL and MULTiplier determine the sweep frequency STOP limit, while the START FREQ control determines the start of the sweep frequency.

SWP: Push-button switch that converts the generator to continuous sweep operation. When the SWP button is depressed the frequency sweep will always begin at the START FREQ setting.

START FREQ: Single turn potentiometer for adjusting the start of the frequency sweep.

DURATION: Single turn potentiometer that determines the sweep duration (rate). Sweep duration is continuously adjustable from 1000 seconds to 1 second, or 1 second to 1 millisecond.

X1K (duration): Push-button control that selects a sweep duration range of 1000s-1s (depressed) or 1s-1ms (out).

WAVEFORM: 3 position, push-button switch for selecting sine (∿) square (⊓), or triangle (△) output waveforms.

AMPLITUDE: Single turn, infinite resolution control for adjustment of the output amplitude from 5mV p-p to 20 volts p-p, open-circuit.

DC OFFSET: Push-button ON-OFF switch, plus separate single turn vernier, for offsetting the DC level of the output waveform between ±10 volts, open-circuit. The combined DC offset plus AC signal should not exceed ±10 volts, open-circuit, or clipping of the waveform may occur.

MAIN OUT:

HI: The selected waveform appears at this output. Impedance, 50 ohms.

LO: The selected waveform appears at this output, attenuated by -20db with respect to the HI output. Impedance, 50 ohms.

VC IN: Provides for external voltage control of frequency. A maximum control voltage of zero to 3 volts will vary the generator frequency to the maximum range of 1500:1. Input impedance, 10k ohms.

CV OUT: DC voltage, proportional to the dial frequency setting, +2mV to +3 volts. In SWP mode, used in conjunction with START FREQ control to set the starting point of the frequency sweep. Output impedance, 600 ohms.

TTL OUT: TTL pulse, coincident with generator frequency, in phase with the main output square wave. Will drive up to 10 TTL loads. Rise and fall times, less than 15ns.

RAMP OUT: Fixed zero to +5 volt linear ramp, rate coincident with sweep DURATION control. Ramp retrace, less than 75 μs. Output impedance, 600 ohms.

2.2.2 Rear Panel

LINE: Complimentary slide switches for selecting 120 or 240 volt operation, and NORMal or LOw line conditions. The 120/240V LINE switch determines the proper voltage range (90-132V or 180-264V) while the NORM/LO LINE switch selects NORMal (108-132, 216-264) or LOw (90-110, 180-220) line voltage.

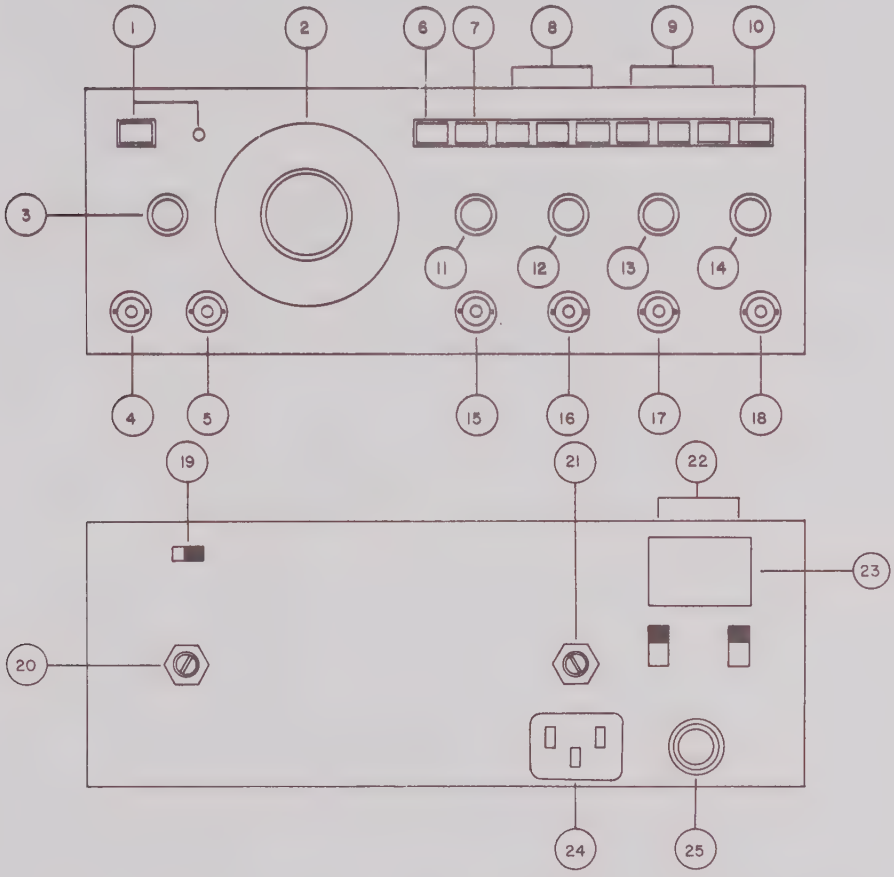
SYM ADJ: Potentiometer for periodic adjustment of the waveform symmetry.

DC OUTPUT LEVEL: Potentiometer for periodic adjustment of the MAIN OUTPUT DC level.

2.3 OPERATION

2.3.1 Frequency Hz/Stop Freq Dial and Multiplier

The generator frequency is controlled by the main tuning (FREQUENCY Hz/STOP FREQ) dial and MULTiplier. The tuning dial is calibrated in Hertz, from 0.2 to 300, for an overall tuning range of 1:1500. The 3 position, push-button MULTiplier multiplies the dial setting by a factor of 1, 100, or 10K (10,000). A separate, single-turn VERNier provides additional fine adjustment of ±2.5% of



1. POWER SWITCH AND INDICATOR
2. FREQUENCY Hz – STOP FREQUENCY DIAL
3. FREQUENCY VERNIER
4. VC INPUT
5. CV OUTPUT
6. SWEEP ON SELECTOR
7. SWEEP DURATION MULTIPLIER
8. FREQUENCY MUTIPLIER
9. WAVEFORM SELECTOR
10. DC OFFSET ON – SELECTOR
11. START – FREQUENCY CONTROL
12. SWEEP DURATION CONTROL
13. AMPLITUDE CONTROL
14. VARIABLE DC OFFSET CONTROL
15. TTL OUTPUT
16. RAMP OUTPUT
17. LO OUTPUT
18. HI OUTPUT
19. GROUND SWITCH
20. DC LEVEL ADJ.
21. SYMMETRY ADJ.
22. AC LINE SELECTOR SWITCHES
23. AC LINE VOLTAGE CHART
24. LINE CORD RECEPTACLE
25. LINE FUSE RECEPTACLE

Figure 3. Operating Controls and Connectors

the dial setting. With the VERNier in the calibrated (0) position, the generator frequency is the dial setting, in Hertz times the MULTiplier.

When the generator is used in the SWP mode, the FREQUENCY dial determines the stopping point of the frequency sweep.

2.3.2 Internal Sweep Operation

When the front panel SWP button is depressed the generator frequency will continuously sweep between the limits set by the START FREQ control and the FREQUENCY Hz/STOP FREQ dial, at a rate determined by the SWP DURATION control. The generator frequency may be either swept up or down, up to a maximum of 1500:1, over the calibrated portion of the tuning dial. To operate the Model 1200A as a sweep generator proceed as follows:

1) Depress the SWP-on button.

2) Select the frequency range within which you wish to sweep by selecting the appropriate frequency MULTiplier range.

SWEEP RANGE	MULTiplier
.2Hz-300Hz	X1
20 Hz-30kHz	X100
2kHz-3MHz	X10k

3) Set the FREQUENCY Hz/STOP FREQ dial to the beginning (start) frequency of the desired sweep range.

4) Connect an oscilloscope to the MAIN OUT connector and adjust the START FREQ control until the frequency stops sweeping. This sets the start frequency at the dial setting.

5) Tune the FREQUENCY Hz/STOP FREQ dial to where you want the frequency sweep to stop.

Once the start frequency is set by the START FREQ control, the stop frequency can be varied over any portion of the FREQUENCY dial, without affecting the start frequency. The generator frequency will sweep linearly over the limits set by the START FREQ control and STOP FREQ dial.

To set the sweep duration, connect a counter to the RAMP OUT and adjust the DURATION control to the desired sweep rate. The DURATION control is a single turn potentiometer that will adjust the sweep duration continuously from 1 second to 1 millisecond. When the DURATION X1K multiplier is in the recessed position, the sweep duration range will be multiplied by a factor of 1,000 (1k). The sweep duration will then cover a range of 1000 seconds to 1 second.

When the generator is used in the non-sweep mode, the RAMP OUT, consisting of a fixed, zero to +5V linear ramp, may be used independently of the main generator, with frequency controlled by the DURATION control.

2.3.3 External Frequency Control (VC)

The generator frequency may also be controlled by an external voltage applied to the VC (voltage control) input. A maximum control voltage of zero to 3 volts will vary the generator frequency up to a ratio of 1500:1 within the range of the

tuning dial. The VC voltage will vary the frequency as the ratio of:

$$\Delta F = \frac{100Hz}{Volt} \times MULTiplier \times VC\ Voltage$$

The VC control is used as follows:

1) With the FREQUENCY dial set to its low (.2) end, a zero to positive-going ramp voltage applied to the VC input will sweep the generator frequency upwards, by as much as 1:1500.

2) If the dial is set to its high (300) end, and a zero to negative-going ramp voltage is applied, the generator frequency will be swept down by 1500:1.

3) A sinusoidal waveform applied to the VC input will modulate (FM) the main output frequency about the dial setting.

As a further example of (3) above, suppose you wish to modulate the generator frequency ±20% of the dial setting. Let us select arbitrary numbers, e.g., dial set at 10kHz (100 x 100), frequency of modulation, 10Hz. From the frequency to VC voltage expression,

Given: $$\Delta F = \frac{100Hz}{Volt} \times MULTiplier \times VC\ Voltage$$

Where: $$\Delta F = \pm 20\% \times 10kHz = \pm 2kHz$$

Therefore, VC Voltage $= \frac{\Delta F}{MULTiplier} \times \frac{1\ Volt}{100Hz}$

$$= \frac{\pm 2 \times 10^{3} Hz \times 1\ Volt}{100 \times 100Hz}$$

$$= \pm .2\ Volts$$

A sinusoidal voltage of ±.2 volts at a rate of 10 Hz is required.

2.3.4 Variable DC Offset

The variable DC OFFSET Control consists of a push-button ON-OFF switch plus a single turn potentiometer. It is used to vary the DC level of the output waveform. The OFFSET potentiometer will vary this level from minus (-) 10 volts to plus (+) 10 volts. The combined peak AC plus DC offset should not exceed ±10 volts peak, otherwise clipping of the waveform may occur.

2.3.5 Calibrated CV (Control Voltage) Output

The calibrated, CV output is a DC voltage proportional to the FREQUENCY dial setting, and covers a range of +2 millivolts to +3 volts. The CV output voltage is accurate to within 5% of the generator's output frequency, over the calibrated range of the dial. It may be connected to a digital voltmeter for monitoring of frequency, or it may be used to drive an x-y plotter. Output impedance is 600 ohms.

It may also be used as an independent ramp output in the SWP mode; its start level and peak amplitude are controlled by the generator's START FREQ and FREQUENCY Hz/STOP FREQ controls, respectively.

2.3.6 Waveguard^{tm} Circuit

The exclusive WAVEGUARD^{tm} output protection circuit is connected across the generator's HI output terminals. The circuit prevents damage to the generator's output amplifier stage, if a voltage greater than ±12 volts is accidently placed across the HI output terminal.

WARNING!

When the WAVEGUARD^{tm} circuit is activated, it will short-circuit the applied voltage to ground.

A low-ohm resistor is inserted in series with the WAVEGUARD^{tm} circuit and the HI output terminal, to protect the WAVEGUARD^{tm} circuit from exceeding its maximum, continuous current rating.

At low frequencies, the circuit will recover automatically when the external voltage is removed; at higher frequencies, it may be necessary to turn the amplitude down or shut the power off momentarilly to reset the circuit after the external voltage is removed.

SECTION 3

INCOMING INSPECTION AND CHECKOUT

3.1 INTRODUCTION

The following procedure should be used to verify that the generator is operating within specifications, both for incoming inspection and for routine servicing. Tests should be made with the cover in place, and the procedure given below should be followed in sequence. Familiarize yourself with the initial setup and operating procedures outlined in Section 2, Operation.

> **CAUTION!**
>
> The cover of this instrument should not be removed when the instrument is connected to an AC power source, because of the potentially dangerous voltages that exist within the unit.

3.2 EQUIPMENT REQUIRED

(a) Oscilloscope, bandwidth from DC to 30MHz, vertical sensitivity 5mV/cm, AC/DC coupled.

(b) Frequency counter, capable of frequency measurements between 0.2Hz and 3 MHz, 0.1% accuracy. (General Radio Model 1192-B, or equivalent).

(c) AC Differential Voltmeter (ACVM), 3MHz bandwidth, capable of measuring AC voltages from zero to 20 volts, and voltage variations less than .1db (1%). (Fluke Model 931A or equivalent).

(d) DC Voltmeter (DCVM), for DC voltage measurements from zero to ±50 volts. (Fluke Model 8000A or equivalent).

(e) Calibrated DC voltage source, zero to ±3 volts. (Analogic Model AN-3100 or equivalent).

(f) Distortion Analyzer. (Krohn-Hite Model 6800 or equivalent).

3.3 PROCEDURE

After allowing the instrument to warm up for at least 30 minutes, set the controls to the following positions:

FREQUENCY Hz/STOP FREQ	30
MULTiplier	x100

SWP	Off
AMPLITUDE	Max CW
Waveform	∿
DC OFFSET	Off
CHASSIS/FLOATING	Chassis

3.3.1 Waveforms

Connect the oscilloscope to the generator's MAIN OUT, (HI Level). Operate the Waveform switch in each of its positions; the waveforms should be present and at least 20 volts peak to peak. Connect the scope to the LO Level output; waveform amplitude should be at least 2 volts peak to peak.

3.3.2 Amplitude Control

Reconnect the scope to the HI Level output. Vary the AMPLITUDE control from maximum to minimum; the waveform amplitude should diminish by more than 60db. Return the AMPLITUDE control to its maximum CW position. Connect a 50 ohm load across the generator's HI OUTPUT; the amplitude should diminish by one-half. Repeat this for the LO OUTPUT. Remove the 50 ohm load.

3.3.3 DC Offset

The variable DC OFFSET Control allows the waveform DC level to be varied ±10 volts peak. Turn the AMPLITUDE control to its maximum CCW position, and connect the scope or DCVM to the HI Level Output. Push the variable OFFSET Control "ON" and vary the control through its range; you should be able to vary the main output DC level by ±10 volts. Push the OFFSET Control to "OFF".

3.3.4 Frequency Controls and Accuracy

Rotate the FREQUENCY dial through its range to insure that it turns smoothly; observe the output waveform on the scope and check to see that the frequency increases as the dial is rotated from its low end (.2) to its high end (300). Operate the MULTiplier in each of its positions and check that the output frequency increases by x 100 steps. Connect the frequency counter to the MAIN OUT, (HI Level, Waveform switch ⊓⊔) and check the accuracy of the FREQUENCY dial in each position of the MULTiplier. Frequency accuracy is specified as within ±5% at dial settings of 10, 100 and 300 and ±20% maximum at all other settings [vernier in 0 (calibrated) position].

3.3.5 External Voltage Control (VC)

An external voltage applied to the VC input will vary the frequency of the generator about the frequency setting of the FREQUENCY dial and MULTiplier. Reconnect the frequency counter to the MAIN OUT. Connect the calibrated DC source to the VC input. Vary the DC source and observe the change in the generator's frequency; a change of ±0.1 volt on the VC input will correspond to a frequency change of approximately 10Hz times the MULTiplier setting.

Disconnect the DC voltage source from the VC input.

3.3.6 CV Output

The CV Output is a DC voltage proportional to the generator frequency. Connect the DCVM to the CV output and check to see that its value is within 5% of the frequency reading observed on the frequency counter. Disconnect the frequency counter and DCVM.

3.3.7 Sweep Operation

To check the sweep operation, set the sweep controls to the following positions:

SWP	On (recessed)
START FREQ	Max CCW
DURATION	1s
DURATION x 1K	Off (Out)

Connect the oscilloscope to the RAMP OUT and check to see that the RAMP is present and its amplitude is zero to +5V. Turn the DURATION Control Max CW; the duration should decrease to approximately 1ms. Depress the duration x1K button; the ramp duration should increase to approximately 1 second.

Connect the oscilloscope to the MAIN OUTPUT. The start of the frequency sweep is adjusted by first setting the FREQUENCY Hz/STOP FREQ dial to the desired frequency, and then by adjusting the START FREQ Control until the frequency stops sweeping. The FREQUENCY Hz/STOP FREQ dial is then tuned to the desired stop frequency. Observe that the frequency sweep range varies as you vary the FREQUENCY Hz/STOP FREQ setting. Return the SWP Control to the off (extended) position.

3.3.8 Frequency Response

The frequency response of the generator is defined as the variations in the amplitude of the output waveform, as the frequency of the generator is varied through its specified range. The response specifications apply to sinewave output, only. The response of the generator may be checked by 1 of 2 methods. If the ACVM is used, connect it to the generator's MAIN OUT and observe the variations in amplitude as the frequency is tuned through its range.

The alternative, and perhaps more convenient method is to sweep the generator frequency using the internal sweep, and observe the swept response on the scope. To use this method, set the FREQUENCY Hz/STOP FREQ dial to 300 x 10k; depress the SWP button and adjust the duration control for 1ms. Adjust the START FREQ control until the frequency stops sweeping, then tune the dial to .2; this will sweep the generator frequency down from approximately 3MHz to 2kHz.

For either method, the variations in output amplitude are specified as less than 0.1db (approx. 1%) up to 300kHz, and less than 1.0db to 3MHz. Return the SWP button to the off (extended) position.

3.3.9 Sinewave Distortion

Connect the distortion analyzer to the generator's MAIN OUT. Set the Waveform switch to $\wedge$. Check the distortion of the output sinewave at the various frequencies. Distortion should be less than 0.5% from 2Hz to 300kHz.

For distortion measurements between 300kHz - 3MHz, the use of a Wave or Spectrum Analyzer is recommended. Distortion is specified as less than 3% to 3MHz.

3.3.10 TTL Output

Connect the oscilloscope to the TTL output, and set the generator frequency to between 1-10kHz. Check to see that the waveform amplitude is between approximately +.3V to +3.0V.

SECTION 4

CIRCUIT DESCRIPTION

4.1 SYSTEM OPERATION

A simplified block diagram of the Model 1200A is shown in Figure 4.

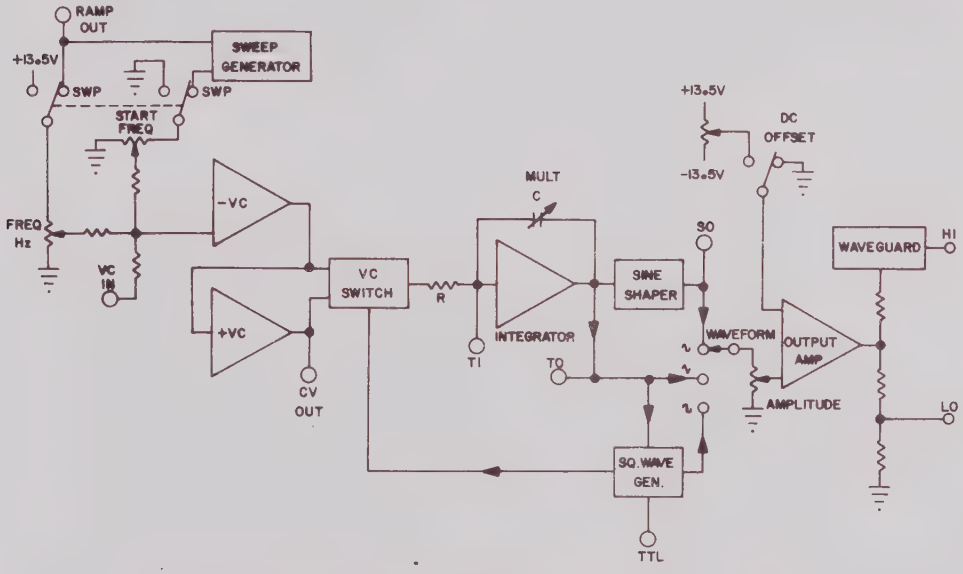


Figure 4. Model 1200A Simplified Block Diagram

The basic oscillating loop consists of the Integrator and the Square Wave Generator. The frequency of oscillation is determined by the output of the +VC and -VC Amplifiers, and the time-constant of the Integrator R and C elements. The frequency is controlled by, (1) varying the +VC and -VC voltage levels by means of the FREQUENCY Hz dial, the internal sweep, or the external VC input, or (2) by changing the value of the integrating capacitor, C via the MULTiplier switch.

The FREQUENCY dial potentiometer is tied to the +13.5V supply during continuous frequency operation, and to the output of the sweep circuit during sweep operation. In the non-sweep mode, the frequency control voltage for the VC Amplifiers is from the center arm of this potentiometer. The external VC input sums its fixed or time-varying voltage with the center arm voltage, at the input to the -VC Amplifier. During the sweep operation, the center arms of the FREQUENCY dial and the START FREQ Control feed the inverting input, while the inverted sweep output feeds the non-inverting input. The width and duration of the generator's sweep frequency is controlled by the front panel SWP Controls.

The +VC and -VC voltages are alternately tied to the input of the Integrator by the VC switching circuit. To describe one cycle of operation, assume the +VC voltage is tied to the Integrator input through R. A negative-going ramp is produced on the Integrator output, and is fed to the Square Wave Generator. The Square Wave Generator triggers during the negative excursion of the Integrator output and changes state, driving the VC switches, which in turn, tie the -VC voltage to the Integrator input. The negative input to the Integrator forces its output to reverse its direction, and a positive-going ramp is produced. The Square Wave Generator again triggers during the Integrator output's positive excursion, and returns to its initial state, driving the VC switches, tying the +VC voltage to the Integrator input and completing the cycle.

The output of the Integrator is a triangle waveform, and is fed to the input of the Square Wave Generator, the input of the Sine Shaper and to the Output Amplifier. The output from the Square Wave Generator is used to drive the VC switching circuit and also provides the square wave to the Output Amplifier and the TTL output. The Sine Shaper converts its triangle input to a sine wave with minimum non-linearites (typically .25%) and is fed to the Output Amplifier. The three functions are tied into the Waveform switch, which in turn feeds the Output Amplifier through AMPLITUDE potentiometer R604. The Output Amplifier provides a 20 volt p-p output and a low impedance drive for the generator's 50 ohm output.

The Power Supply provides a regulated ±13.5 volts DC to all circuits.

4.2 VC AMPLIFIERS AND VC SWITCHING

The +VC and -VC Amplifiers produce an equal, positive and negative DC voltage, respectively. The VC voltage and the integration time-constant of the R-C elements determine the system's frequency of oscillation. The +VC and -VC Amplifiers are operational amplifiers consisting of U200, U201 respectively and emitter followers, Q200, Q201 respectively. The input voltage is from the FREQUENCY dial potentiometer center arm and/or the external VC input, and is applied to the inverting input of U200, the -VC Amplifier. The center arm of the START FREQ control is tied to the non-inverting input during SWP operation. The -VC Amplifier exhibits a gain of less than -1. Potentiometer R219 varies the gain of the -VC Amplifier ±2.5%. The -VC voltage at the output of U200 is coupled through an emitter follower stage Q200, to provide the negative current to the Integrator. The -VC voltage is fed to the input of U201, which functions as a unity gain inverter. The +VC voltage on the output of U201 is fed through emitter follower Q201 and provides the positive current to the Integrator.

The +VC and -VC voltages are alternately switched in every half-cycle by the VC switching circuit and applied to the Integrator input. The switching circuit consists of two pairs of FETS Q202-Q203 and Q204-Q205 driven by a differential signal developed by the Square Wave Generator (Sec. 4.4). Potentiometer R228 compensates for symmetry variations at the high end of the dial due to impedance differences of the FET switches Q203 and Q205.

4.3 INTEGRATOR

The Integrator consists of an inverting amplifier with very high gain, plus a capacitor C in feedback to provide the integrating function. The Integrator is driven from the output of the VC Switch.

The amplifier consists of a differential input stage Q300, a differential second stage Q301-Q302, a driver stage Q303, an output amplification stage Q304-Q306 and an emitter follower stage, Q305-Q307.

The output of the Integrator is a triangle waveform and is fed to the Output Amplifier, to the input to the Sine Shaper and to the input of the Square Wave Generator. Capacitor C is selected by the MULTiplier. Potentiometer R300 provides symmetry adjustment at the low end of the dial.

4.4 SQUAREWAVE GENERATOR

The Square Wave Generator consists of an IC sense amplifier, U500, a hysteresis switch Q500, a differential buffer stage Q501-Q502, and a TTL output stage Q503-Q504.

The output of the Integrator is fed to the input of the Square Wave Generator. The hysteresis is determined by the current in CR501 and R506 in the positive direction of the Integrator output, and by the current in R408, CR500, CR501, and R506 in the negative direction. One-half of the differential output of U500 drives Q206 and Q207 which in turn control the VC switches. The output from Q501 drives the follower-clamp transistors Q503-Q504 providing the TTL output. The output from Q502 is fed to the Output Amplifier through the Waveform switch.

4.5 SINE WAVE SHAPER

The Sine Wave Shaper processes the triangle waveform from the Integrator output and generates a sinewave that exhibits typically .25% non-linearity (distortion). The shaping network consists of five pairs of diodes, each pair associated with a voltage divider. Transistors Q400-Q401 set the levels at which the diodes clamp, which in turn vary the slope of the triangle waveform at five (5) discrete points within each 90° or quarter-cycle. A two-stage amplifier further processes the sine wave function for use as the MAIN output waveform, and consists of a differential input stage Q402-Q403 and a driver stage Q404-Q407. An emitter follower output stage Q405-Q406 provides a low impedance drive to the output amplifier. Potentiometers R411 and R416 minimize the distortion level by optimizing the clamping level.

4.6 OUTPUT AMPLIFIER

The Output Amplifier amplifies the incoming signal selected by the Waveform switch, and provides a low impedance, 20 volt peak to peak source for the generator's 50 ohm output. The Amplifier consists of a balanced input stage Q600-Q601, a driver and output amplification stage Q604, constant current source Q606, and a push-pull emitter follower output stage Q605-Q607. At higher frequencies, transistors Q602-Q603 provide an additional balanced drive for Q604-Q606 via capacitors C612 and C615. The Amplifier has an overall gain of approximately 5, set by resistors R606, R607. AMPLITUDE potentiometer R604 varies the input to the Amplifier resulting in a control of the output voltage swing. DC level potentiometer R600 is provided to zero any output offset voltage. Potentiometer R602 provides a DC offset adjustment on the amplifier's output via R603; its operation is not affected by the position of the AMPLITUDE potentiometer, R604.

4.7 SWEEP CIRCUIT

The sweep circuit generates a positive ramp voltage that drives the FREQUENCY dial potentiometer in the SWP mode of operation. The circuit consists of a

charging or integrating capacitor C716, a buffer amplifier stage U702-Q704, current source U701, Q702, R711 and R712, a sense amplifier U700, hysteresis switch Q700-Q701 and a capacitor discharge switch Q703.

In describing a cycle of operation, the current source charges capacitor C716, in turn producing a positive ramp or integrating voltage that is buffered through amplifier U702 and follower Q704. The output of Q704 is detected by the sense amplifier, U700. The hysteresis of the sense amplifier is determined by the current through R704 and R705. During the charging cycle, the output of U700 is held to a positive level of +1.8 volts by feedback limiting diodes CR702-CR703. This level holds Q701 and Q703 off. As the ramp voltage increases, the current through R707 increases, in turn decreasing the current through CR702, CR703. When the ramp voltage reaches approximately +5 volts, no current will flow through CR702 and CR703, and the input of U700 will not be held at zero by the feedback. This will force its output to go negative, turning on CR701 and limiting the output of U700 to -.6V. When this happens, Q701 will turn on and open the current path via CR700 from R704-R705 to the sense amplifier input. At the same time, CR704 turns off, turning on Q703 and discharging the capacitor. With the ramp voltage at zero, and no current through CR700, the input to the sense amplifier will no longer be held by the feedback. This will force the sense amplifier output positive to +1.8V; CR704 turns on, shutting off Q703 and Q701 and allowing C716 to charge again.

4.8 POWER SUPPLY

The power supply provides ±13.5 volts regulated power to all circuits. The supply consists of two (2) series pass regulator circuits, with the +13.5 volt as the slave to the -13.5 volt supply. Zener reference VR100 sets a reference voltage on the input of sense amplifier U110, which detects any variations in the -13.5 volt supply. The output of U110 drives the base of transistor Q111. The collector of Q111 in turn drives the base of series pass regulator Q110, to compensate for the supply variation.

The +13.5 volt supply is the slave to the -13.5 volt supply. Variations in the +13.5 supply will be sensed by amplifier U100 through resistor divider R106-R108. The output of U100 drives the base of Q101 which in turn controls regulator Q100.

4.9 WAVEGUARD^{tm}

The WAVEGUARD^{tm} circuit is shown in Figure 5. It is connected across the generator's HI output terminals. It consists of a triac (Q610) and back-to-back, 12 volt zener diodes (VR600, VR601). Under normal conditions, no current flows through the zener diodes, the triac gate will be at zero potential and the triac will be turned off. When the external voltage across the HI output terminals exceeds approximately ±12 volts, VR600 and VR601 will conduct; the resulting current produces a voltage potential across R641 which turns on Q610. When Q610 is turned on, the external voltage will be clamped to ground.

A low ohm resistor, R642, is placed in series with the WAVEGUARD^{tm} circuit and the HI output terminal, to prevent the triac from exceeding its maximum, continuous current rating. If this occurs, it may be necessary to replace the resistor.

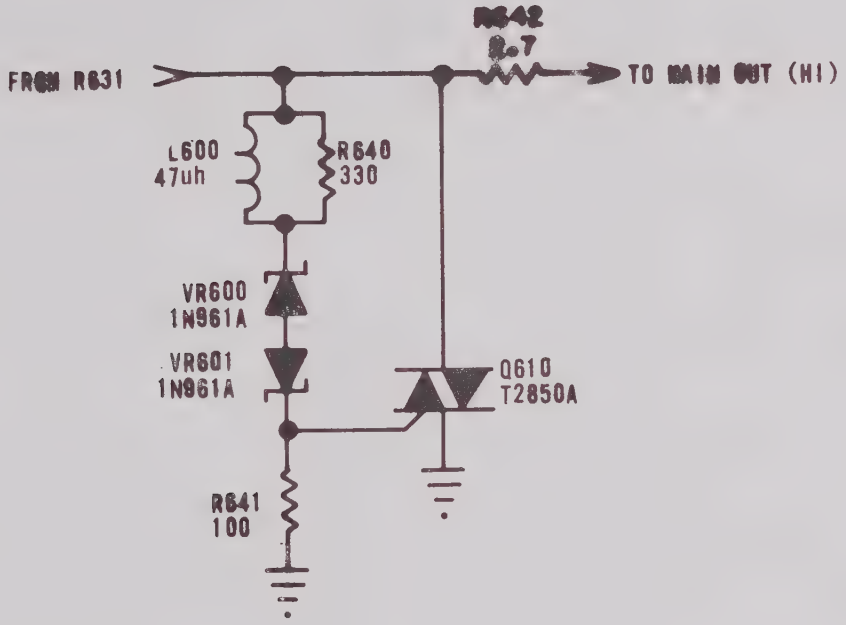


Figure 5. WAVEGUARD^{tm} Circuit.

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

If the generator is not functioning properly and requires service the following procedure may facilitate locating the source of trouble. Access to the interior of the generator is accomplished by removing the two screws on either side of the instrument; the cover will then easily lift off.

If a malfunction is detected, first check the line voltage and line fuse, and then make an inspection for broken wires, burnt or loose components, intermittent solder joints or similar conditions which may cause trouble. Before beginning this procedure it should be determined if the normal adjustments mentioned in the Calibration Procedure, Section 6, will correct the trouble. Any trouble-shooting of the generator will be greatly simplified if there is an understanding of the operation of the circuit; reference should be made to Section 4, Circuit Description.

WARNING!

This maintenance procedure should be performed by qualified personnel, only. If the cover must be removed during the troubleshooting procedure, it is strongly recommended that extra precautions be taken in working with exposed circuitry, and that insulated probes and/or tools be used.

SHUT THE POWER SWITCH OFF AND DISCONNECT THE LINE CORD FROM THE POWER SOURCE BEFORE REPAIRING OR REPLACING COMPONENTS.

5.2 TROUBLESHOOTING PROCEDURE

After allowing the instrument to warm up for at least several minutes, set the controls to the following positions:

FREQUENCY Hz/STOP FREQ	100
VERNier	0 (cal)
MULTiplier	100
Waveform	∿
AMPLITUDE	Max CW
DC OFFSET	Off (Out)
SWP	Off (Out)
DURATION	Max CW
x1K	Off (Out)

Table 1 is provided to help localize the malfunction to a specific circuit with reference to sub-section paragraphs to further help to locate the defective component(s). Refer to the schematic at the rear of this manual, for normal AC and DC voltages mentioned throughout the procedure.

TABLE 1. TROUBLESHOOTING CHART

Symptom	Check	If Incorrect Probable Cause	Sub-Section Paragraph
1. No signal MAIN output, TTL output ok	Center arm of AMPLITUDE control pot, R604 for ~3V p-p ∿ signal	Waveform switch	-
	If correct	Output Amplifier or WAVEGUARD circuit	5.2.6
2. No sine wave on MAIN output	Check for ±3V p-p ∿ signal at TP TO.	Sine Shaper	5.2.5
	If correct	Waveform switch	-
3. No square wave on MAIN output	Check collector of Q502 for ~±2.5V p-p ⊓ signal	Q501, Q502	-
	If correct	Waveform switch	-
4. No TTL output	Check collector of Q501 for ~6V p-p ⊓ signal	Q503, Q504	-
5. No signal on MAIN or TTL outputs	Supply voltages for ±13.5V, ±0.5V	Fuse, rectifier, malfunction in regulated supplies; short-circuit or low impedance from supply bus to ground	5.2.1
	FREQUENCY dial center arm (pin 15) for +3.8V, ±0.5V	R800 and/or associated network; SWP switch S200A	5.2.2
	Output of -VC Amplifier (emitter of Q200) for -1V, ±0.2V	U200, Q200 or related components	5.2.2
	Output of +VC Amplifier (TP VC) for +1V, ±0.2V	U201, Q201 or related components	

Symptom	Check	If Incorrect Probable Cause	Sub-Section Paragraph
5. Con't	Polarity of TP TO should be opposite that of TP TI	Integrator	5.2.3
	If TP TO more pos. than +8V, pin 6 of U500 ~+4.5V and pin 7 of U500 ~+.2V	U500, Q500 or related components	5.2.4
	If TP TO more neg. than -8V, pin 6 of U500 ~+.2V and pin 7 of U500 ~+4.5V	U500, Q500 or related components	5.2.4
	When TP TO more pos. than +8V, collector of Q206 ~-10V and collector of Q207 +1V	Q202-Q204, Q206, Q207	5.2.4
	When TP TO more neg. than -8V, collector of Q206 ~-1V and collector of Q207 ~-10V	Q202-Q204 Q206, Q207	5.2.4
6. RAMP output ok, but generator frequency does not sweep up or down when SWP button is depressed	+5V to 0V Ramp signal on pin 6 of U703	U703 or related components	5.2.7
7. No RAMP output	Emitter of Q704 for 0V to +5V Ramp signal	Sweep Circuit	5.2.7

5.2.1 Power Supply

The Power Supply for the generator provides a plus and minus 13.5 volts. If either supply voltage is low it may be due to excessive load current. The supplies are designed to shut down if shorted, with current only being supplied through series shunt resistors R101 and R110.

If the -13.5 volt supply is operating normally, but the +13.5 volt supply is not, the variation of the plus supply voltage will produce a minus supply voltage of about double the magnitude of the voltage across zener reference VR100.

The following procedure will localize the trouble to the area where the expected measurement does not occur.

If the -13.5 volt supply is incorrect, check the zener reference voltage across VR100. If the zener voltage is correct but the -13.5 volts is more negative than normal, pin 2 of U110 should read negative, making its output pin 6, more positive than normal. Q111 should be driven off, turning off series pass transistor Q110 which will force the -13.5 volts to be more positive.

If the -13.5 volts is less negative than normal, check the minus unregulated voltage and ripple frequency to determine if the rectifiers, CR101 and CR103, and the filter capacitor, C110, are defective. If these measurements are correct, trace the error correcting voltage as above using opposite polarities.

If the +13.5 volt supply is in error, first check the -13.5 volts, used for its reference. A normally operating plus supply should develop a voltage equal in magnitude to the minus supply. If not operating properly, trace the error correcting voltage as in the minus supply to localize the trouble area.

5.2.2 VC Amplifiers

If the voltage at the center arm of the FREQUENCY dial R800, is correct, the voltage at the junction of R206 and R207 should be correct and appear at one side of R209.

In the following procedure, the measurement that deviates from the expected result will localize the trouble. For opposite polarity errors, the same error correcting voltage may be traced with opposite polarities expected.

In the -VC Amplifier, if the emitter of Q200 is more negative than normal, pin 2 of U200 should be negative making pin 6 of U200 more positive, correcting the voltage at the emitter of Q201.

FET switches Q202, Q203, Q204 and Q205 are driven from the Square Wave Generator through Q206 and Q207. If the generator is not oscillating, either Q202 and Q203 or Q204 and Q205 will be switched on connecting the corresponding VC voltage to the Integrator input, TI. When Q206 is not conducting and Q207 is, Q204 and Q205 will be switched on and Q202 and Q203 will be switched off.

5.2.3 Integrator

If the generator is not oscillating, the trouble is in either the Integrator, the Square Wave Generator, or the VC circuit.

If the output of the Integrator, TO, has a dc offset greater than ±8 volts and is of opposite polarity to its input, TI, the Integrator is probably functioning properly.

If the polarity of the Integrator's output is the same polarity as its input the following signal tracing procedure should aide in localizing the trouble.

If the input, TI, is positive, the collectors of Q300 should be unbalanced with the input collector R302 being less positive than R303 collector. This should turn on Q302 making its collector more positive than normal, making the emitter of Q303 more positive, turning on Q306, in turn turning on Q307, making the output, TO, more negative. In the same manner, if the input and output are negative, the error correcting voltage levels may be traced from input to output.

5.2.4 Square Wave Generator

If the triangle output, TO, has a dc level greater than ±8 volts and it has been determined that the Integrator is functioning properly, the most likely source of trouble is either the Square Wave Generator or the VC circuit.

With the triangle output greater than +8 volts, the pin 2 input of U500 should be more positive than pin 3 input. This should make pin 6 output more positive than pin 7 output. If pin 6 is more positive than pin 7, the base of VC switch driver Q206 should be more positive than the base of Q207, turning on Q206 and turning off Q207. This will turn off VC FET switches Q204 and Q205 and turn on switches Q202 and Q203, connecting a positive voltage source to the input of the Integrator, TI, through R239 and R236.

The trouble will be localized to the area at which these correct measurements do not occur. In like manner if the output of the Integrator is negative, the same procedure may be used with opposite polarity readings.

As pin 6 of U500 alternately switches from a high state to a low state it drives Q500 off and on, which alternately changes the current to the input of U500, in turn reversing the polarity required from the output of the Integrator to flip U500. When pin 6 of U500 is high (4.5 volts), Q500 is off. The current supplied to the input of U500 through R508 and CR500 requires the output of the Integrator to reach approximately -8 volts to flip U500.

The output of U500 is also used to drive Q501 and Q502 and provide the square drive signal to the Output Amplifier and the TTL transistors Q503 and Q504.

5.2.5 Sine Shaper

If the triangle is present at the Integrator output, TO, with minimum dc offset, and a distorted output or no output appears at the Sine Wave Shaper output, TP SO the trouble may be localized as follows:

A defective diode, CR400 thru CR409 or resistance divider, R400 thru R409, will usually produce a distorted signal at TP SO.

A faulty amplifier component will generally result in a dc offset at TP SO. If SO has a dc offset greater than plus 1 volt, the error correcting voltage may be traced by measuring the collector of Q402. Q402 collector should be more positive than normal. This should turn off Q404 making the base of emitter follower Q405 more negative, restoring the output to zero. The error correcting measurement that does not occur will localize the problem.

5.2.6 Output Amplifier

A defective Output Amplifier will usually result in a dc level at the output when the AMPLITUDE control is max CCW (assuming the DC OFFSET control is turned off). The error correcting levels may be traced through the Output Amplifier in the following manner. If the dc level at the output is positive, feedback thru R600 should turn on Q600 and turn off Q601. The collector of Q601 will be more positive than normal making the base of Q604 more positive than normal, turning off Q604. Q604 collector will be more negative, in turn making the output more negative through emitter followers Q605 and Q606.

A defect in Q602 and Q603 may only show up at high frequencies.

If the correct signal appears at the junction of R624 and R631, but not at the HI output, check for a faulty WAVEGUARD circuit, an open resistor R642 or an open connection from PC101 to the HI output terminal.

5.2.7 Sweep Circuit

The ramp output should be present at all times and if inoperative will most likely have either a zero dc level or a 5 volt dc level. Determine if the RAMP output is not working by turning the DURATION control full CCW and depressing the DURATION X1K button. If the RAMP output is plus 5 volts or greater, pin 6 of U700 should be negative about .6 volts. This should allow the emitter of Q703 to move negative, turning on Q703 and discharging C716. Pin 6 output of unity gain amplifier U702 should follow its negative input making the emitter follower, Q704 go negative to zero. As the output of U700 alternates positive and negative, Q701 should turn on in the negative direction, and off in the positive direction. This will make CR700 conduct when Q701 is off and not conduct when Q701 is on. This action alternately changes the maximum (5 volts) and minimum (0 volts) trip points of U700. If the ramp output is less than +5V, pin 6 of U700 should be positive, pulling the emitter of Q703 positive thru diode CR704, turning off Q703. This should allow C716 to charge positive from constant current source Q702 and U701. As C716 charges, the output of U703 should follow making the emitter follower output (Q704) go positive.

In the SWP mode, the RAMP output is connected through unity gain inverting amplifier U703 to the inputs of -VC Amplifier U200.

SECTION 6

CALIBRATION

6.1 INTRODUCTION

The following procedure is provided for the calibration and adjustment of the generator in the field, and adherence to this procedure should restore the generator to its original performance specifications. If the generator cannot be calibrated by the procedure given, refer to Maintenance, Section 5, or consult our Factory Service Department. The location of all test points and adjustable components may be found in the circuit layout drawing at the rear of this manual.

6.2 EQUIPMENT REQUIRED

(a) Oscilloscope, bandwidth from DC to 30 MHz, vertical sensitivity 5 mV/cm, AC/DC coupled. (Tektronix type 544 Mainframe with type 1A1 Vertical Amplifier Plug-in).

(b) Frequency Counter, capable of frequency measurements between .2Hz and 3MHz, 0.1% accuracy. (General Radio 1192-B or equivalent).

(c) Digital Multimeter (DMM) for DC voltages between zero and ±50 volts, and AC voltages up to 20 volts. (Fluke Model 8000A or equivalent).

(d) Distortion Analyzer, bandwidth at least 300 kHz, to measure distortion down to 0.1% (Krohn-Hite Model 6800 or equivalent).

6.3 TEST PROCEDURE

After turning the generator on, allow it to warm up for at least 30 minutes, then set the controls to the following positions:

FREQUENCY Hz/STOP FREQ	300
MULTiplier	x1
VERNier	0 (cal)
Waveform	∿
AMPLITUDE	Max. CCW

Initially set all screwdriver-adjustable trims to the center of their range (including rear panel SYM ADJ and DC LEVEL potentiometers).

WARNING!

This calibration procedure should be performed by qualified personnel only. Remove the cover before connecting the instrument to the AC source and use only insulated probes and/or tools.

6.3.1 Power Supply Check

Connect the DMM to the -13.5V test point, and check for a reading of -13.5V, ±0.5V. Connect the DMM to the +13.5V test point and check for a reading of +13.5V, ±0.5V.

6.3.2 Main Output DC Level Adjust

Set AMPLITUDE pot to max CCW. Connect the DMM (DC Mode) to the MAIN (HI) OUT; adjust the DC LEVEL ADJ potentiometer on the rear panel for zero ±.001V on the MAIN OUT.

6.3.3 Triangle Amplitude and DC Level Adjust

With the DMM still connected to the MAIN OUT, turn the AMPLITUDE pot Max CW; adjust R505 for zero, ±.001V reading on the MAIN OUT.

Switch the DMM to AC Mode and adjust R503 for a triangle amplitude of 5.6V, ±.02V.

6.3.4 ±VC Amplifiers DC Level Adjust

Connect the DMM (DC Mode) to the VC IN connector (J802); adjust R215 for a reading of zero, ±.2mV.

Connect the DMM to pin 2 of U201; adjust R224 for a reading of zero, ±.2mV.

6.3.5 Symmetry and Distortion Adjustment

Set the FREQUENCY Hz dial to 50, MULTiplier to x100. Set the Waveform switch to ∿. Connect the generator MAIN (HI) OUT to the distortion analyzer input.

Tune the distortion analyzer to 5kHz. Adjust R234, then R411 and R416 for a minimum distortion reading. Tolerance: less than 0.4%.

Set the FREQUENCY Hz dial to 300; readjust the distortion analyzer for 30kHz. Adjust R228 for a distortion reading of less than 0.4%.

Set the FREQUENCY Hz dial to 0.2; readjust the distortion analyzer for 20Hz. Adjust the rear panel SYM ADJ potentiometer, R300, for minimum distortion. Disconnect the distortion analyzer.

6.3.6 Sine Shaper DC Level

Connect DMM (DC Mode) to test point SO; adjust R424 or R425 (or R438 if present) for a reading of zero, ±1.0mV.

NOTE

Trim R425 for a positive reading, R424 for a negative reading. Trim value is approximately 1.2 megohm per 5mV.

6.3.7 Frequency Calibration

Set the FREQUENCY Hz dial to its maximum CW (0.2) end; check the alignment of the "Δ" symbol with the dial index. If necessary loosen dial set screws, readjust dial and retighten set screws.

NOTE

To eliminate backlash, always approach the desired setting from the CCW (300 end) direction.

Connect the frequency counter to the TTL output. Set the generator VERNier to the middle of its range (0). Set the FREQUENCY Hz dial to the following settings and adjust each potentiometer for the counter reading indicated.

Dial Setting	Adjustment	Counter Reading
300	R241	30.0kHz, ±0.6kHz
(Set counter to PERIOD operation)		
0.2	R205	50ms, ±1.0ms
(Reset counter for FREQUENCY operation)		
10	R201	1.00kHz, ±0.02kHz
100	R203	10.0kHz, ±0.2kHz

Repeat above adjustment, if necessary, until all are correct.

Reset FREQUENCY Hz dial to 10, MULTiplier to x10k. Adjust C330 for a frequency reading of 100kHz, ±2kHz.

Set FREQUENCY Hz dial to 100; adjust C500 for a reading of 1.000MHz, ±.02MHz.

Set FREQUENCY Hz dial for 300; adjust R500 for a counter reading of 3.00MHz, ±.06MHz. Remove frequency counter.

6.3.8 Squarewave Amplitude and DC Level

Set the FREQUENCY Hz dial to 300, MULTiplier to x1. Set the Waveform switch to ⊓⊔ , AMPLITUDE control to Max. CW. Set the DMM to AC mode and connect it to the MAIN (HI) OUT; adjust R528 for a reading of 11.2V, ±0.02V.

Switch on the DMM to DC mode and adjust R530 for a squarewave DC level of zero, ±0.001V. Disconnect the DMM.

6.3.9 Squarewave Response

Set the FREQUENCY Hz dial to 100, MULTiplier to x10k. Connect the oscilloscope to the MAIN (HI) OUT, using a 50 ohm terminator at the scope vertical input. Adjust the scope horizontal and vertical controls for two cycles approximately 5cm in height. Adjust C607 for a flat square wave.

6.3.10 Amplitude Change vs. Dial Tuning

Connect the oscilloscope to the MAIN OUT (HI terminal). Set the FREQUENCY Hz dial to 1. Waveform switch to ∿ . Turn the AMPLITUDE control

Max. CCW, and adjust the scope vertical sensitivity for a 6cm display. Tune the dial to 300 and adjust C419 for no change when tuning the dial from 1 to 300.

Disconnect the scope from the MAIN OUT.

6.3.11 Ramp Zero Adjust

Connect the clipping circuit between the generator and oscilloscope as shown in Figure 6.

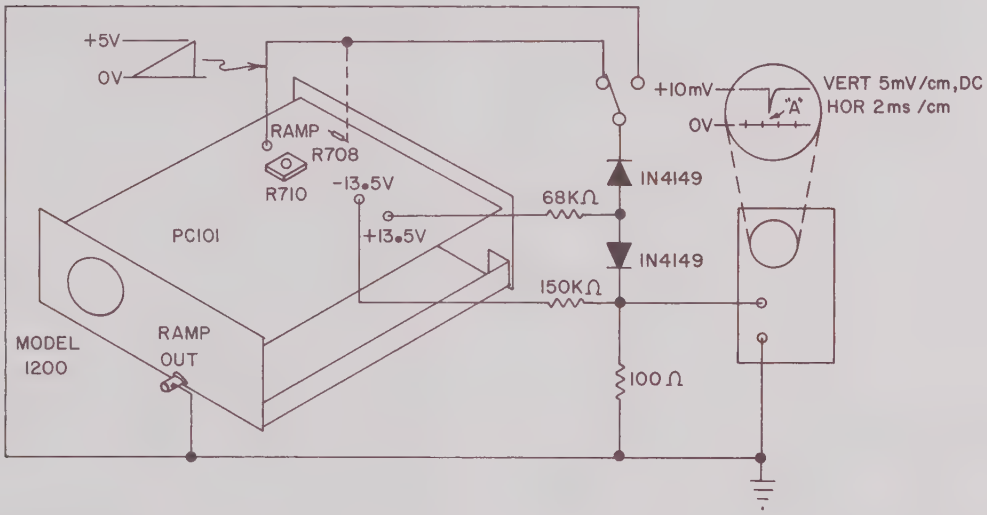


Figure 6. Test Set-up for Step 6.3.11

Set the DURATION control to mid-range. Set the scope INPUT COUPLING to DC. Momentarily connect the clipping circuit input to ground and center the scope trace.

NOTE

If the scope trace cannot be centered, it is probably due to a mismatch in the two diodes used; try a different pair.

Connect the clipping circuit input to either the junction of R708 and emitter of Q704 or to test point RAMP, (whichever is applicable) and adjust R710, RAMP ZERO ADJ so that the negative peak on the scope display (point "A") touches the scope zero volt center line. Disconnect the clipping circuit.

6.3.12 Sweep Null Calibration

Set the scope INPUT COUPLING switch to AC, and connect the scope and the DVM to the generator CV OUTput. Set the FREQUENCY Hz/STOP FREQ. dial to 300. Measure the CV OUTput voltage with the DVM and record the reading.

Depress the SWP button and adjust the START FREQ control for a minimum CV output signal on the scope. Adjust R718, SWP NULL, for the same DVM reading as previously recorded, ±10mV.

6.3.13 Sweep Calibration

Set the scope vertical sensitivity to 0.5 volt/cm, DC coupled. Set the SWP control to the off (out) position; adjust the scope trace so that it coincides with the top graticule line. Depress the SWP button and adjust R705, SWP CAL, so that the peak of the ramp touches the top graticule line. Disconnect all test equipment from the generator.

SHUT THE POWER SWITCH OFF AND DISCONNECT THE LINE CORD BEFORE REPLACING THE INSTRUMENT COVER.

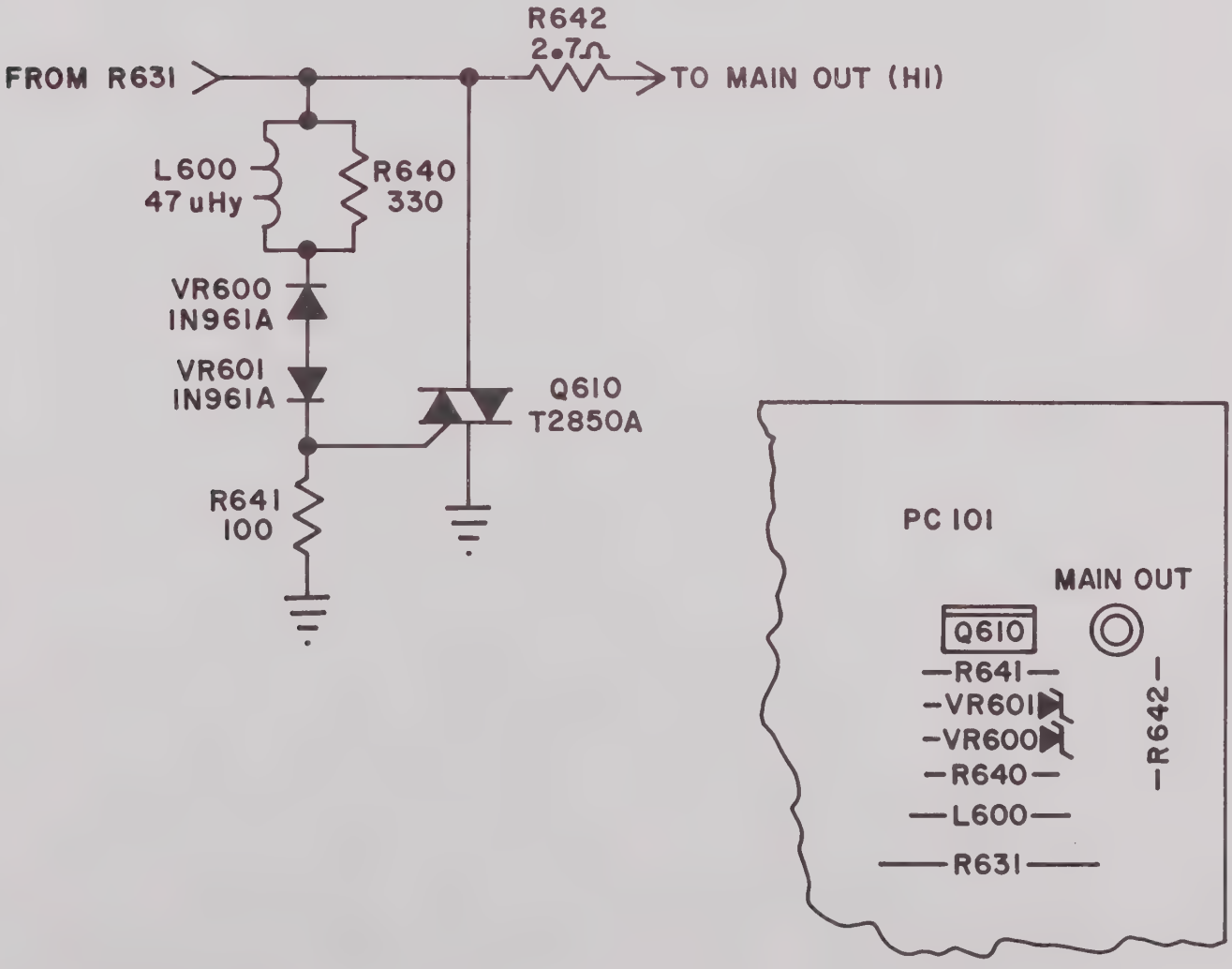
MODEL 1000 AND MODEL 1200

OUTPUT PROTECTION CIRCUIT

This instrument is equipped with an output protection circuit that is designed to protect the generator's output amplifier from damage if an external voltage (greater than 12 volts) is accidently placed across the generator's HI OUTPUT terminals. A triac, Q610, will turn on, clamping both the generator's 50 ohm output and the external source voltage to ground, thereby limiting the current flow through the generator's output stage.

The output stage will withstand a short-circuit across the MAIN OUTPUT for a short period of time with no damage to the output stage.

At low frequencies, the circuit will automatically recover when the external voltage is removed. At higher frequencies, it may be necessary to turn the amplitude down, or shut the generator off momentarily to reset the circuit, after the external voltage is removed.

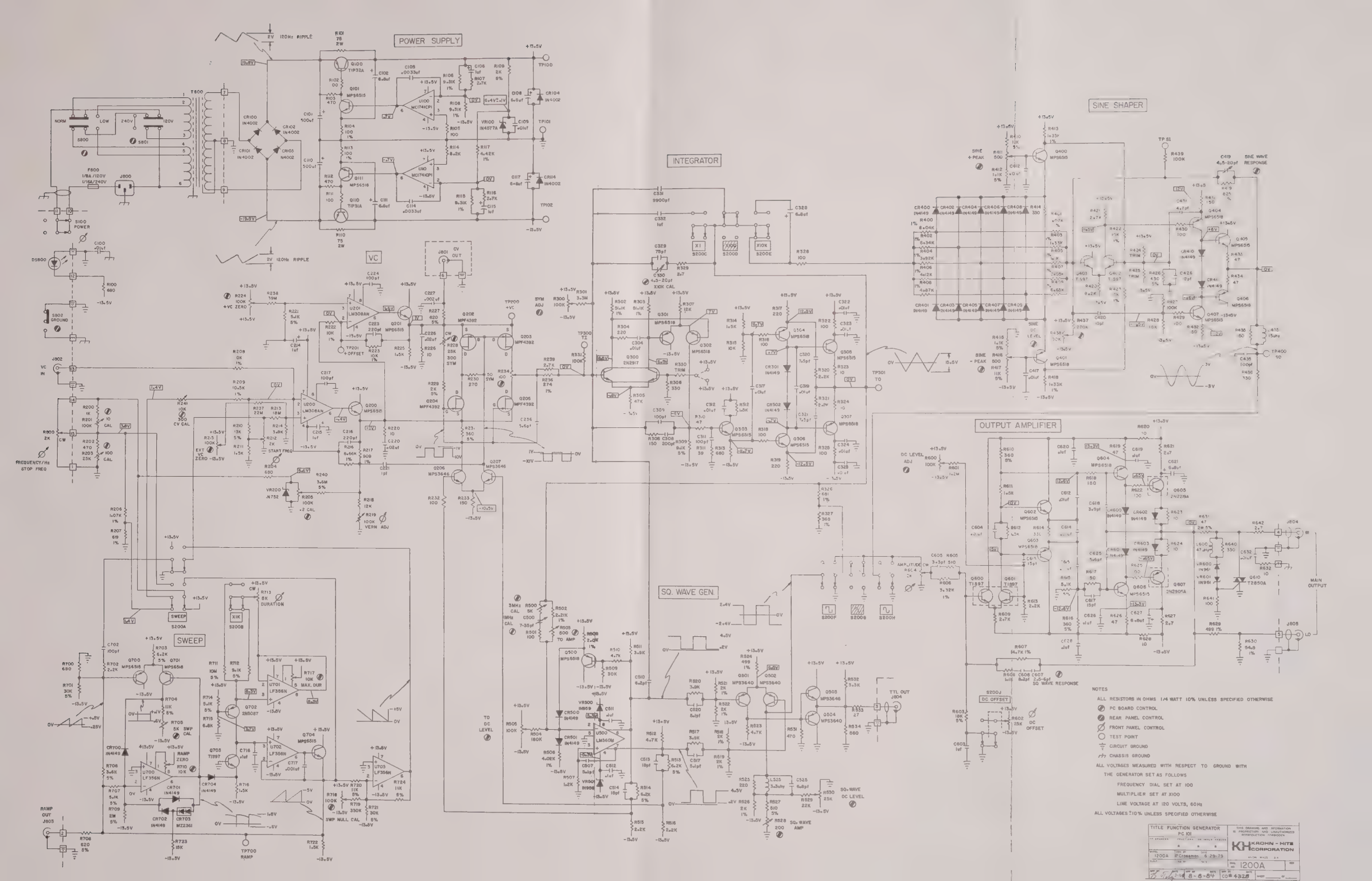


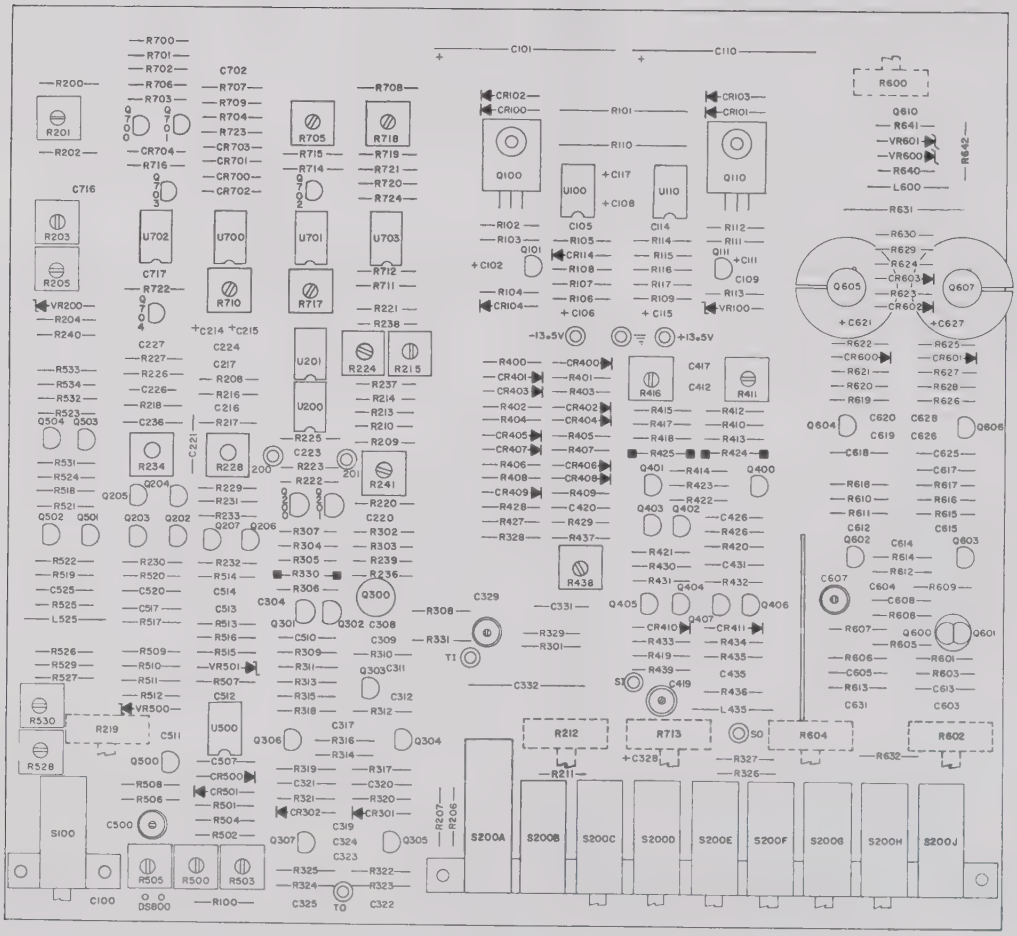
PARTS LIST

SCHEMATIC REFERENCE	DESCRIPTION			MFR.	PART NUMBER
R640	330	10%	1/4W	AB	CB3311
R641	100	10%	1/4W	AB	CB1011
R642	2.7	10%	1/4W	AB	CB27G1
L600	47uHy	10%	.4W	DLV	1537-60
Q610	TRIAC			RCA	T2850A
VR600	DIODE, ZENER, 10V			TR	1N961B
VR601	DIODE, ZENER, 10V			TR	1N961B

MANUFACTURER'S CODE

AB	Allen Bradley Co.
BUS	Bussman Mfg. Co.
DLV	Delevan Electronics
RCA	RCA Semiconductor Div.
TR	Transitron Electric


POWER SUPPLY
INTEGRATOR
SINE SHAPER
VC
SWEEP
SQ. WAVE GEN.
OUTPUT AMPLIFIER
NOTES
ALL RESISTORS IN OHMS 1/4 WATT 10% UNLESS SPECIFIED OTHERWISE
PC BOARD CONTROL
REAR PANEL CONTROL
FRONT PANEL CONTROL
TEST POINT
CIRCUIT GROUND
CHASSIS GROUND
ALL VOLTAGES MEASURED WITH RESPECT TO GROUND WITH
THE GENERATOR SET AS FOLLOWS
FREQUENCY DIAL SET AT 100
MULTIPLIER SET AT X100
LINE VOLTAGE AT 120 VOLTS, 60Hz
ALL VOLTAGES ±10% UNLESS SPECIFIED OTHERWISE
TITLE FUNCTION GENERATOR
PC 101
1200A
KRONH-HITE CORPORATION
1200A



PC101
MODEL 1200A

CAPACITORS

Symbol	Description			Mfr.	Part No.
C100	.01uf	20%	500V	SP	C023B501G103M
C101	500uf		25V	MAL	TT501N025GP
C102	6.8uf	20%	35V	SP	150D685X0035B2
C105	.0033uf	20%	1000V	SP	5GA-D33
C106	1uf	20%	35V	MAL	TDC105M035AL
C108	6.8uf	20%	35V	SP	150D685X0035B2
C109	.01uf	20%	500V	SP	C023B501G103M
C110	500uf		25V	MAL	TT501N025GP
C111	6.8uf	20%	35V	SP	150D685X0035B2
C114	.0033uf	20%	1000V	SP	5GA-D33
C115	1uf	20%	35V	MAL	TDC105M035AL
C117	6.8uf	20%	35V	SP	150D685X0035B2
C214	1uf	20%	35V	MAL	TDC105M035AL
C215	1uf	20%	35V	MAL	TDC105M035AL
C216	220pf	10%	500V	ELM	DM15C221K
C217	100pf	10%	500V	ELM	DM15C101K
C220	.02uf	20%	500V	SP	C023A501J203M
C221	.1pf	10%	500V	QC	TYPE QC
C223	220pf	10%	500V	ELM	DM15C221K
C224	100pf	10%	500V	ELM	DM15C101K
C226	.02uf	20%	500V	SP	C023A501J203M
C227	.002uf	20%	500V	SP	C023B501F202M
C236	5.6pf	10%	500V	ASP	9210-56910
C304	.01uf	20%	500V	SP	C023B501G103M
C308	200pf	10%	500V	ELM	DM15C201K
C309	100pf	10%	500V	ELM	DM15C101K
C311	100pf	10%	500V	ELM	DM15C101K
C312	.01uf	20%	500V	SP	C023B501G103M
C317	.01uf	20%	500V	SP	C023B501G103M
C319	.01uf	20%	500V	SP	C023B501G103M
C320	7.5pf	10%	500V	ASP	9212-75910
C321	7.5pf	10%	500V	ASP	9212-75910
C322	.01uf	20%	500V	SP	C023B501G103M
C323	.01uf	20%	500V	SP	C023B501G103M
C324	.01uf	20%	500V	SP	C023B501G103M
C325	.01uf	20%	500V	SP	C023B501G103M
C328	6.8uf	20%	35V	SP	150D685X0035B2
C329	75pf	10%	500V	ELM	DM15C750K
C330	4.5-20pf TRIMMER			STT	7S-TR1K0-02-4.5/20pf
C331	9900pf	1%	100V	ELM	CD20FD992F03
C332	1uf	+.5%,-3.5%	200V	KH	KHC-11-105
C412	.01uf	20%	500V	SP	C023B501G103M

Symbol	Description			Mfr.	Part No.
C417	.01uf	20%	500V	SP	C023B501G103M
C419	4.5-20pf TRIMMER			STT	7S-TR1K0-02-4.5/20pf
C420	10pf	10%	500V	ASP	9213-10110
C426	12pf	10%	500V	ASP	9213-12110
C431	4.7pf	10%	500V	QC	Type QC
C435	100pf	10%	500V	ELM	DM15C101K
C500	7-35pf TRIMMER			STT	7S-TR1K0-02-7/35pf
C507	5.1pf	10%	500V	ASP	9210-51910
C510	6.2pf	10%	500V	ASP	9212-62910
C511	.1uf	20%	100V	ERT	8131-100-651-104M
C512	.1uf	20%	100V	ERT	8131-100-651-104M
C513	18pf	10%	500V	ELM	DM15C180K
C514	18pf	10%	500V	ELM	DM15C180K
C517	5.1pf	10%	500V	ASP	9210-51910
C520	5.1pf	10%	500V	ASP	9210-51910
C525	6.8pf	10%	500V	ASP	9212-68910
C603	.01uf	20%	500V	SP	C023B501G103M
C604	.01uf	20%	500V	SP	C023B501G103M
C605	5.1pf	10%	500V	ASP	9210-51910
C607	2.5-6pf TRIMMER			STT	7S-TR1K0-02-2.5/6pf
C608	8.2pf	10%	500V	ASP	9212-82910
C612	.01uf	20%	500V	SP	C023B501G103M
C613	15pF	5%	500V	ELM	DM15C150J
C614	.01uf	20%	500V	SP	C023B501G103M
C615	.01uf	20%	500V	SP	C023B501G103M
C617	15pF	5%	500V	ELM	DM15C150J
C618	10pf	10%	500V	ASP	9213-10110
C619	.1uf	20%	100V	ERT	8131-100-651-104M
C620	.1uf	20%	100V	ERT	8131-100-651-104M
C621	6.8uf	20%	35V	SP	150D685X0035B2
C625	5.6pF	10%	500V	ASP	9210-56910
C626	.1uf	20%	100V	ERT	8131-100-651-104M
C627	6.8uf	20%	35V	SP	150D685X0035B2
C628	.1uf	20%	100V	ERT	8131-100-651-104M
C632	.01uf	20%	500V	SP	C023B501G103M
C702	100pf	10%	500V	ELM	DM15C101K
C716	.1uf	+1%,-3%	200V	KH	KHC-11-104
C717	.001uf	20%	500V	SP	C023B501E102M

RESISTORS

Symbol	Description			Mfr.	Part No.
R100	680	10%	1/4W	AB	CB6811
R101	75	5%	2W	AB	HB7505
R102	100	10%	1/4W	AB	CB1011
R103	470	10%	1/4W	AB	CB4711
R104	100	1%	1/4W	KH	850109
R105	8.2K	10%	1/4W	AB	CB8221
R106	9.31K	1%	1/4W	AB	CC9311F
R107	2.7K	10%	1/4W	AB	CB2721
R108	9.31K	1%	1/4W	AB	CC9311F
R109	2K	5%	1/4W	AB	CB2025
R110	75	5%	2W	AB	HB7505
R111	100	10%	1/4W	AB	CB1011
R112	470	10%	1/4W	AB	CB4711
R113	100	1%	1/4W	KID	M3-1000-T1F
R114	8.2K	10%	1/4W	AB	CB8221
R115	9.31K	1%	1/4W	AB	CC9311F
R116	2.7K	10%	1/4W	AB	CB2721
R117	4.42K	1%	1/4W	AB	CC4421F
R200	1K	10%	1/4W	AB	CB1021
R201	100K	POT		BKM	72PM
R202	470	10%	1/4W	AB	CB4711
R203	25K	POT		BKM	72PM
R204	680	10%	1/4W	AB	CB6811
R205	100K	POT		BKM	72PM
R206	1.07K	1%	1/4W	AB	CC1071F
R207	619	1%	1/4W	AB	CC6190F
R208	10K	1%	1/4W	AB	CC1002F
R209	10.5K	1%	1/4W	AB	CC1052F
R210	13K	5%	1/4W	AB	CB1335
R211	1.5K	10%	1/4W	AB	CB1521
R212	2K	POT(START FREQ)		KH	B3765-1-A
R213	18M (TRIM)			AB	CB1861

Symbol	Description			Mfr.	Part No.
R214	3.9K	10%	1/4W	AB	CB3921
R215	100K	POT		BKM	72PM
R216	8.66K	1%	1/4W	AB	CC8661F
R217	909	1%	1/4W	AB	CC9090F
R218	12K	10%	1/4W	AB	CB1231
R219	100K	POT (VERN)		KH	B3765-3-A
R220	10	10%	1/4W	AB	CB1001
R221	5.1K	5%	1/4W	AB	CB5125
R222	10K	1%	1/4W	AB	CC1002F
R223	10K	1%	1/4W	AB	CC1002F
R224	100K	POT		BKM	72PM
R225	1.5K	10%	1/4W	AB	CB1521
R226	10	10%	1/4W	AB	CB1001
R227	620	5%	1/4W	AB	CB6215
R228	25K	POT		BKM	72PM
R229	2K	5%	1/4W	AB	CB2025
R230	270	10%	1/4W	AB	CB2715
R231	360	5%	1/4W	AB	CB3615
R232	100	10%	1/4W	AB	CB1011
R233	150	10%	1/4W	AB	CB1511
R234	100	POT		BKM	72PM
R236	274	1%	1/4W	AB	CC2740F
R237	22M	10%	1/4W	AB	CB2261
R238	39M	10%	1/4W	AB	CB3961
R239	2.7K	10%	1/4W	AB	CB2721
R240	3.6M	5%	1/4W	AB	CB3655
R241	10K	POT		BKM	72PM
R300	100K	POT (SYM ADJ)		KH	A3100
R301	3.3M	10%	1/4W	AB	CB3351
R302	51.1K	1%	1/4W	AB	CC5112F

RESISTORS

Symbol	Description			Mfr.	Part No.
R303	51.1K	1%	1/4W	AB	CC5112F
R304	220	10%	1/4W	AB	CB2211
R305	47K	10%	1/4W	AB	CB4731
R306	330	10%	1/4W	AB	CB3311
R307	12K	10%	1/4W	AB	CB1231
R308	150	10%	1/4W	AB	CB1511
R309	9.1K	5%	1/4W	AB	CB9125
R310	47	10%	1/4W	AB	CB4701
R311	39	10%	1/4W	AB	CB3901
R312	1.5K	10%	1/4W	AB	CB1521
R313	680	10%	1/4W	AB	CB6811
R314	1.5K	10%	1/4W	AB	CB1521
R315	10K	10%	1/4W	AB	CB1031
R316	100	10%	1/4W	AB	CB1011
R317	220	10%	1/4W	AB	CB2211
R318	100	10%	1/4W	AB	CB1011
R319	220	10%	1/4W	AB	CB2211
R320	2.2K	10%	1/4W	AB	CB2221
R321	2.2K	10%	1/4W	AB	CB2221
R322	100	10%	1/4W	AB	CB1011
R323	10	10%	1/4W	AB	CB1001
R324	10	10%	1/4W	AB	CB1001
R325	100	10%	1/4W	AB	CB1011
R326	681	1%	1/4W	AB	CC6810F
R327	365	1%	1/4W	AB	CC3650F
R328	100	10%	1/4W	AB	CB1011
R329	2.7	10%	1/4W	AB	CB27G1
R330	TRIM			AB	Type CB
R331	100K	10%	1/4W	AB	CB1041
R400	6.04K	1%	1/4W	AB	CC6041F
R401	1.07K	1%	1/4W	AB	CC1071F
R402	6.34K	1%	1/4W	AB	CC6341F
R403	1.33K	1%	1/4W	AB	CC1331F
R404	3.92K	1%	1/4W	AB	CC3921F
R405	1.1K	1%	1/4W	AB	CC1101F
R406	4.12K	1%	1/4W	AB	CC4121F
R407	2.05K	1%	1/4W	AB	CC2051F
R408	4.87K	1%	1/4W	AB	CC4871F
R409	6.65K	1%	1/4W	AB	CC6651F
R410	11K	5%	1/4W	AB	CB1135
R411	500	POT		BKM	72PM
R412	1.1K	5%	1/4W	AB	CB1125
R413	1.33K	1%	1/4W	AB	CC1331F
R414	330	10%	1/4W	AB	CB3311
R415	1.1K	5%	1/4W	AB	CB1125
R416	500	POT		BKM	72PM
R417	11K	5%	1/4W	AB	CB1135
R418	1.33K	1%	1/4W	AB	CC1331F
R419	825	1%	1/4W	AB	CC8250F
R420	8.2K	10%	1/4W	AB	CB8221
R421	2.7K	10%	1/4W	AB	CB2721
R422	10K	1%	1/4W	AB	CC1002F
R423	10K	1%	1/4W	AB	CC1002F
R424	TRIM			AB	TYPE CB
R425	TRIM			AB	TYPE CB
R426	430	5%	1/4W	AB	CB4315
R427	100K	10%	1/4W	AB	CB1041
R428	18K	10%	1/4W	AB	CB1831
R429	100	10%	1/4W	AB	CB1011
R430	100	10%	1/4W	AB	CB1011
R431	150	10%	1/4W	AB	CB1511
R432	150	10%	1/4W	AB	CB1511
R433	47	10%	1/4W	AB	CB4701
R434	47	10%	1/4W	AB	CB4701
R435	150	10%	1/4W	AB	CB1511
R436	330	10%	1/4W	AB	CB3311
R437	270K	10%	1/4W	AB	CB2741
R438	100K	POT		BKM	72PM
R439	100K	10%	1/4W	AB	CB1041
R500	5K	POT		BKM	72PM
R501	100	10%	1/4W	AB	CB1011
R502	2.21K	1%	1/4W	AB	CC2211F
R503	500	POT		BKM	72PM
R504	270K	10%	1/4W	AB	CB2741
R505	100K	POT		BKM	72PM
R506	4.02K	1%	1/4W	AB	CC4021F
R507	1.2K	10%	1/4W	AB	CB1221
R508	2K	1%	1/4W	AB	CC2001F
R509	30K	5%	1/4W	AB	CB3035
R510	4.7K	10%	1/4W	AB	CB4721

Symbol	Description			Mfr.	Part No.
R511	3.9K	10%	1/4W	AB	CB3921
R512	4.7K	10%	1/4W	AB	CB4721
R513	6.2K	5%	1/4W	AB	CB6225
R514	6.2K	5%	1/4W	AB	CB6225
R515	2.2K	10%	1/4W	AB	CB2221
R516	2.2K	10%	1/4W	AB	CB2221
R517	3.9K	10%	1/4W	AB	CB3921
R518	2K	1%	1/4W	AB	CC2001F
R519	2K	1%	1/4W	AB	CC2001F
R520	3.9K	10%	1/4W	AB	CB3921
R521	2K	1%	1/4W	AB	CC2001F
R522	2K	1%	1/4W	AB	CC2001F
R523	4.7K	10%	1/4W	AB	CB4721
R524	499	1%	1/4W	AB	CC4990F
R525	220	10%	1/4W	AB	CB2211
R526	2K	1%	1/4W	AB	CC2001F
R527	510	5%	1/4W	AB	CB5115
R528	200	POT		BKM	72PM
R529	22K	10%	1/4W	AB	CB2231
R530	25K	POT		BKM	72PM
R531	470	10%	1/4W	AB	CB4711
R532	3.3K	10%	1/4W	AB	CB3321
R533	27	10%	1/4W	AB	CB2701
R534	560	10%	1/4W	AB	CB5611
R600	100K	POT (DC LEVEL ADJ)		KH	A3100
R601	1.2M	10%	1/4W	AB	CB1251
R602	25K	POT (DC OFFSET)		KH	B3765-2
R603	18K	5%	1/4W	AB	CB1835
R604	2K	POT (AMPLITUDE)		KH	B3765-1-A
R605	100	10%	1/4W	AB	CB1011
R606	3.32K	1%	1/4W	AB	CC3321F
R607	14.7K	1%	1/4W	AB	CC1472F
R608	1.1K	5%	1/4W	AB	CB1125
R609	2.7K	10%	1/4W	AB	CB2721
R610	360	5%	1/4W	AB	CB3615
R611	1.5K	10%	1/4W	AB	CB1521
R612	1.5K	10%	1/4W	AB	CB1521
R613	2.2K	10%	1/4W	AB	CB2221
R614	330	10%	1/4W	AB	CB3311
R615	5.1K	5%	1/4W	AB	CB5125
R616	360	5%	1/4W	AB	CB3615
R617	150	10%	1/4W	AB	CB1511
R618	150	10%	1/4W	AB	CB1511
R619	47	10%	1/4W	AB	CB4701
R620	10	10%	1/4W	AB	CB1001
R621	2.7	10%	1/4W	AB	CB27G1
R622	100	10%	1/4W	AB	CB1011
R623	10	10%	1/4W	AB	CB1001
R624	10	10%	1/4W	AB	CB1001
R625	100	10%	1/4W	AB	CB1011
R626	47	10%	1/4W	AB	CB4701
R627	2.7	10%	1/4W	AB	CB27G1
R628	10	10%	1/4W	AB	CB1001
R629	499	1%	1/4W	AB	CC4990F
R630	54.9	1%	1/4W	AB	CC54R9F
R631	47	5%	2W	AB	HB4705
R632	10	10%	1/4W	AB	CB1001
R700	680	10%	1/4W	AB	CB6811
R701	30K	5%	1/4W	AB	CB3035
R702	2.2K	10%	1/4W	AB	CB2221
R703	6.2K	5%	1/4W	AB	CB6225
R704	11K	5%	1/4W	AB	CB1135
R705	5K	POT		BKM	72PM
R706	3.6K	5%	1/4W	AB	CB3625
R707	5.1K	5%	1/4W	AB	CB5125
R708	620	5%	1/4W	AB	CB6215
R709	2M	5%	1/4W	AB	CB2055
R710	10K	POT		BKM	72PM
R711	9.1M	5%	1/4W	AB	CB9155
R712	9.1K	5%	1/4W	AB	CB9125
R713	5K POT (DURATION)			KH	B3765-4-A
R714	5.1K	5%	1/4W	AB	CB5125
R715	6.8K	10%	1/4W	AB	CB6821
R716	1.5K	10%	1/4W	AB	CB1521
R717	10K	POT		BKM	72PM
R718	100K	POT		BKM	72PM
R719	330K	10%	1/4W	AB	CB3341
R720	11K	5%	1/4W	AB	CB1135
R721	30K	5%	1/4W	AB	CB3035
R722	1.5K	10%	1/4W	AB	CB1521
R723	15K	10%	1/4W	AB	CB1531
R724	11K	5%	1/4W	AB	CB1135
R800	2K POT (FREQUENCY HZ)			KH	B4056-A

TRANSISTORS, DIODES & MISC.

Symbol	Description	Mfr.	Part No.
Q100	TIP32A	TI	TIP32A
Q101	MPS6515	MOT	MPS6515
Q110	TIP31A	TI	TIP31A
Q111	MPS6518	MOT	MPS6518
Q200	MPS6515	MOT	MPS6515
Q201	MPS6515	MOT	MPS6515
Q202	MPF4392	MOT	MPF4392

Symbol	Description	Mfr.	Part No.
Q203	MPF4392	MOT	MPF4392
Q204	MPF4392	MOT	MPF4392
Q205	MPF4392	MOT	MPF4392
Q206	MPS3646	MOT	MPS3646
Q207	MPS3646	MOT	MPS3646
Q300	2N2917	MOT	2N2917
Q301	MPS6518	MOT	MPS6518
Q302	MPS6518	MOT	MPS6518

TRANSISTORS, DIODES & MISC.

Symbol	Description	Mfr.	Part No.
Q303	MPS6515	MOT	MPS6515
Q304	MPS6518	MOT	MPS6518
Q305	MPS6515	MOT	MPS6515
Q306	MPS6515	MOT	MPS6515
Q307	MPS6518	MOT	MPS6518
Q400	MPS6515	MOT	MPS6515
Q401	MPS6518	MOT	MPS6518
Q402	TIS97	TI	TIS97
Q403	TIS97	TI	TIS97
Q404	MPS6518	MOT	MPS6518
Q405	MPS6515	MOT	MPS6515
Q406	MPS6518	MOT	MPS6518
Q407	MPS6515	MOT	MPS6515
Q500	MPS4258	MOT	MPS6518
Q501	MPS3640	MOT	MPS3640
Q502	MPS3640	MOT	MPS3640
Q503	MPS3646	MOT	MPS3646
Q504	MPS3640	MOT	MPS3640
Q600	TIS97	TI	TIS97
Q601	TIS97	TI	TIS97
Q602	MPS6515	MOT	MPS6515
Q603	MPS6518	MOT	MPS6518
Q604	MPS6518	MOT	MPS6518
Q605	2N2219A	MOT	2N2219A
Q606	MPS6515	MOT	MPS6515
Q607	2N2905A	MOT	2N2905A
Q700	MPS6518	MOT	MPS6518
Q701	MPS6518	MOT	MPS6518
Q702	2N5087	MOT	2N5087
Q703	TIS97	TI	TIS97
Q704	MPS6515	MOT	MPS6515
U100	MC1741CP1	MOT	MC1741CP1
U110	MC1741CP1	MOT	MC1741CP1
U200	LM308AN	NS	LM308AN
U201	LM308AN	NS	LM308AN
U500	LM360M, 8-PIN DIP	NS	LM360M-8
U700	LF356N, 8-PIN DIP	NS	LF356N-8
U701	LF356N, 8-PIN DIP	NS	LF356N-8
U702	LF356N, 8-PIN DIP	NS	LF356N-8
U703	LF356N, 8-PIN DIP	NS	LF356N-8
VR100	IN4577A, 6.4V	NS	IN4577 A
VR200	IN752, 5.6V	APD	IN752
VR500	IN959, 8.2V	APD	IN959
VR501	IN959, 8.2V	APD	IN959
CR100	IN4002	ITT	IN4002
CR101	IN4002	ITT	IN4002
CR102	IN4002	ITT	IN4002
CR103	IN4002	ITT	IN4002
CR104	IN4002	ITT	IN4002

Symbol	Description	Mfr.	Part No.
CR114	IN4002	ITT	IN4002
CR301	IN4149	APD	IN4149
CR302	IN4149	APD	IN4149
CR400	IN4149	APD	IN4149
CR401	IN4149	APD	IN4149
CR402	IN4149	APD	IN4149
CR403	IN4149	APD	IN4149
CR404	IN4149	APD	IN4149
CR405	IN4149	APD	IN4149
CR406	IN4149	APD	IN4149
CR407	IN4149	APD	IN4149
CR408	IN4149	APD	IN4149
CR409	IN4149	APD	IN4149
CR410	IN4149	APD	IN4149
CR411	IN4149	APD	IN4149
CR500	IN4149	APD	IN4149
CR501	IN4149	APD	IN4149
CR600	IN4149	APD	IN4149
CR601	IN4149	APD	IN4149
CR602	IN4149	APD	IN4149
CR603	IN4149	APD	IN4149
CR700	IN4149	APD	IN4149
CR701	IN4149	APD	IN4149
CR702	IN4149	APD	IN4149
CR703	MZ2361	APD	MZ2361
CR704	IN4149	APD	IN4149
DS800	LED, INDICATOR, POWER ON	MOT	MV2025
F800	FUSE, SLOW-BLOW, 115V	BUS	MDL .2A
	FUSE, SLOW-BLOW, 230V	BUS	MDL .2A
J800	RECEPTACLE, AC POWER	SWC	EAC-301
J801	CONNECTOR, FEMALE BNC	KH	B2440
J802	CONNECTOR, FEMALE BNC	KH	B2440
J803	CONNECTOR, FEMALE BNC	KH	B2440
J804	CONNECTOR, FEMALE BNC	KH	B2440
J805	CONNECTOR, FEMALE BNC	KH	B2440
J806	CONNECTOR, FEMALE BNC	KH	B2440
L435	15uH	DLV	1537-40
L525	3.3uH	DLV	1537-24
S100	SWITCH, PUSHBUTTON, POWER	KH	B3386
S200	SWITCH, PUSHBUTTON, 9 STATION	KH	B3767-A
S800	SWITCH, SLIDE, NORM/LO	SWC	46206LFR
S801	SWITCH, SLIDE 120V/240V	SWC	46206LFR
S802	SWITCH, SLIDE, GROUND	SWC	GF123
T800	TRANSFORMER, POWER	KH	B3779-A
	LINECORD	PI	13E37-1

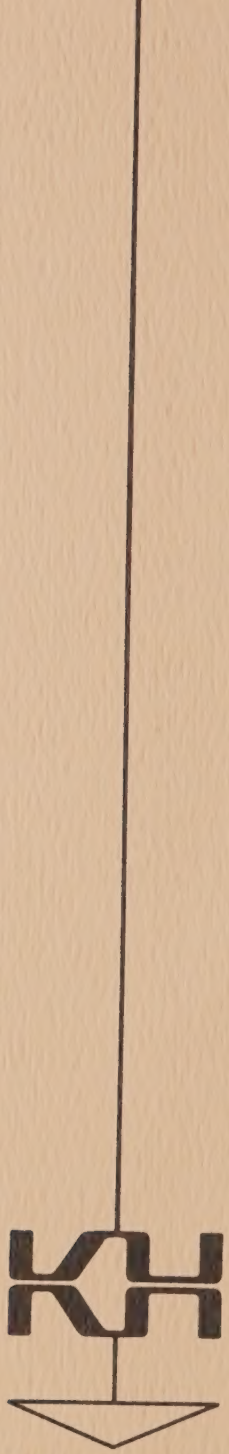
MANUFACTURERS' CODE

AB	(01121)	Allen Bradly Co.	Milwaukee, Wisc.
APD	(50273)	American Power Devices	Andover, Mass.
ASP	(82142)	Airco Speer	Dubois, Pa.
BKM	(30646)	Beckman Instr. Co.	Cedar Grove, N.J.
BUS	( )	Bussman Manufacturing Co.	St. Louis, Mo.
DLV	(99800)	Delevan Electronics	East Aurora, N.Y.
ELM	(72136)	Electromotive Mfg.	Willimantic, Conn.
ERT	(72982)	Erie Technological	Erie, Pa.
ITT	( )	ITT Semiconductor	Woburn, Mass.

KH	(88865)	Krohn-Hite Corp.	Avon, Mass.
MAL	(37942)	P.R. Mallory & Co.	Indianapolis, Ind.
MOT	(04713)	Motorola Semiconductor	Phoenix, Ariz.
NS	(36462)	National Semiconductor LTD	Plattsburgh N.Y.
PI	( )	Phillips Industries	Chicago, Ill.
SP	(56289)	Sprague Electric Co.	North Adams, Mass.
STT	( )	Stettner-Trush	Cazanovia, N.Y.
SWC	(82389)	Switchcraft Inc.	Chicago, Ill.
TI	(01295)	Texas Instruments, Inc.	Dallas, Texas

WAVEGUARD™:

L600	47uH	10%	.4W	DLV	1537-60
R640	330	10%	1/4W	AB	CB3311
R641	100	10%	1/4W	AB	CB1011
R642	2.7	10%	1/4W	AB	CB27G1
Q610	TRIAC			RCA	T2850A
VR600	DIODE, ZENER, 10V			TR	1N961B
VR601	DIODE, ZENER, 10V			TR	1N961B



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